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Notes on the Flora of South Georgia

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During the summers of 1895, 1896 and 1897 I devoted most of my time to botanizing in and around Americus, the county seat of Sumter County, Georgia, which was my home at that time. As this region is almost unknown to botanists, I had excellent opportunity to observe many little-known or otherwise interesting plants, some of them far out of their accredited ranges.

Sumter County is situated in the western part of that section known as South Georgia, which includes about 64 counties, with an area of 35,000 square miles, or over half the area of the State. South Georgia is sharply defined both geologically and topographically from the older sections of the State, especially from Middle Georgia, which adjoins it on the northwest. It varies in elevation from sea-level to about 600 feet, and contains three distinct geological formations. Of these, the Cretaceous is represented by a narrow wedge-shaped area in the northwestern portion, and the Quaternary by a narrow strip along the coast and larger rivers, while the remainder belongs to the Tertiary formation.

Sumter County, as far as known, lies entirely in the Tertiary, though its northwestern corner approaches within a short distance of the Cretaceous. The predominating soil in Sumter County, as throughout South Georgia, is sand, generally mixed with more or less clay, organic matter, or marl; the latter being principally confined to the vicinity of the Flint River, on the eastern border of the county.

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The average annual temperature of Americus is 68° F., with the following averages for the four seasons: spring, 68°; summer, 81°; autumn, 69°; winter, 54°. The average rainfall is for spring, 13 inches; summer, 16; autumn, 8; winter, 10; total for the year, 47. It will be noticed that over one third of the total annual precipitation occurs in the summer, a fact which, no doubt, has its effect on the character of the flora.

Of the numerous floral and agricultural regions into which South Georgia is divided, I have noticed but two principal ones in Sumter County: the red-clay hill region and the pine-barren region. The former seems to correspond with the Lower Eocene formation and the latter with the Middle Eocene. The red-clay hills form a belt extending across the northwestern part of the county, and consist of low, rounded ridges, with broad valleys between them. The pine-barrens are in the southeastern part, and are almost perfectly level throughout. Both regions, like the whole of South Georgia, are characterized by the scarcity of surface rocks, the few that do occur being in the form of small boulders or pebbles.

The city of Americus lies near the dividing line between these two regions, so that I had equal facilities for studying both. With the exception of two trips into Dooly County, on the east, and one each into Schley and Macon Counties on the north, my botanical operations during these three summers were confined to Sumter County. This vicinity is remarkable for the large number of coast plants which here reach their inland limits, 125 miles from the Gulf coast and about 200 from the Atlantic. The region I explored is nearly all north of lat. 32° N. and west of long. 84° W., and at a higher altitude and, of course, farther inland than any point in Florida.

In a preceding number of the BULLETIN I have mentioned the great difference between the floras of Middle and South Georgia. Probably less than one half of the species of spermatophytes in Clarke County are common to Sumter County. On comparing the two floras we find the same kind of differences between them as are said to exist between temperate and tropical regions. In South Georgia the species seem to be more numerous and the individual plants fewer and farther apart (this

is especially noticeable in the case of the grasses); there are more evergreen trees and shrubs and fewer evergreen herbs; and there are more species of climbing plants and epiphytic spermatophytes. Comparing the representation of various families in the two regions, we find in South Georgia more species of Cyperaceae, Orchidaceae, Nymphaeaceae, Magnoliaceae, Leguminosae, Euphorbiaceae, Aquifoliaceae, Rhamnaceae, Malvaceae, Hypericaceae, Melastomaceae, Onagraceae, Halorrhagidaceae, Loganiaceae, Gentianaceae, Asclepiadaceae and Rubiaceae; and fewer species of Cupuliferae, Caryophyllaceae, Ranunculaceae, Cruciferae, Crassulaceae, Saxifragaceae, Rosaceae, Violaceae, Cornaceae and Labiatae. To illustrate the deficiencies in some of the latter families, I will mention that I have found the Caryophyllaceae (exclusive of Illecebraceae) and Cruciferae represented only by a few weeds, the Ranunculaceae only by two or three species of *Clematis*, and the Saxifragaceae only by the shrubby genus *Itea*, with a single species.

The flora of South Georgia, at least of that part of it which I have explored, seems to be more highly differentiated into plant-communities than that of Middle Georgia. I have recognized twelve or fifteen distinct floral areas in Sumter County alone, and this number could no doubt be considerably increased by careful study. The plants of this region seem to be more exacting in their requirements for perfect development than those of colder climates, hence there is very little intergradation between the various plant-communities.

I will mention first the strictly aquatic plants, which inhabit ponds and streams, either floating free or rooting in the mud. These are found mostly in artificial mill-ponds, for natural ponds in this region are very small and few and far between. The following aquatics have been observed in Sumter County:

Potamogeton diversifolius Raf.
lonchites Tuckerm.
Eleocharis interstincta (Vahl) R. & S.
Lemna minor L.
Brasenia purpurea (Mx.) Caspary.
Castalia odorata (Dryand.) Woodv. & Wood.
Myriophyllum heterophyllum Mx.
Limnanthemum lacunosum (Vent.) Griseb.
aquaticum (Walt.) Britton.
Utricularia inflata Walt.

Most of the above I have found in only one or two localities each. It may be of interest to note that *Limnanthemum aquaticum* may be either a rooting or a floating plant. It seems to make no difference to the plant whether its petioles are attached to the rootstock or not, for I have found the plants in great abundance crowded together along the shore of a pond and floating free, with their petioles broken off below the inflorescence, but with flowers open as usual.

In wet ditches and open muddy places I have found the following species:

Sparganium androcladum (Engelm.) Morong.
Sagittaria latifolia Willd.
Paspalum distichum L.
Dulichium arundinaceum (L.) Britton.
Eleocharis obtusa (Willd.) Schult.
Carex lupulina Muhl.
Orontium aquaticum L.
Polygonum hydropiperoides Mx.
Hypericum mutilum L.
Jussiaea decurrens (Walt.) DC.
Jussiaea leptocarpa Nutt.
Ludwigia alternifolia L.
glandulosa Walt.
Isnardia palustris L.
Proserpinaca palustris L.
Hydrocotyle umbellata L.
Cynoctonum Mitreola (L.) Britton.
Micranthemum orbiculatum Mx.
Utricularia macrorhyncha Barnhart.

The following are found in alluvial woods and swamps and on muddy banks of creeks and rivers subject to overflow:

Botrychium obliquum Muhl.
Polypodium polypodioides (L.) A. S. Hitchcock.
Taxodium distichum (L.) L. C. Rich.
Juniperus Virginiana L.
Sabal glabra (Mill.) Sarg.
Arundinaria macrosperma Michx.
Scirpus divaricatus Ell.
Rhynchospora corniculata (Lam.) Gray.
Carex folliculata australis Bailey.
Peltandra Virginica (L.) Kunth.
Tillandsia usneoides L.
Commelina hirtella Vahl.
Iris versicolor L.
Habenaria flava (L.) Gray.
Saururus cernuus L.
Populus deltoides Marsh.
Carpinus Carolinana Walt.
Quercus lyrata Walt.
Michauxii Nutt.
Boehmeria cylindrica (L.) Willd
Liriodendron Tulipifera L.
Clematis crispa L..
Penthorum sedoides L.
Ilex opaca Ait.
Berchemia scandens (Hill) Trel.
Triadenum petiolatum (Walt.) Britton.
Hydrocotyle verticillata Thunb.
Cornus Amonum Mill.

Nyssa uniflora Wang.
Leucothoë racemosa (L.) Gray.
Fraxinus Americana L.
Caroliniana Mill.
Chionanthus Virginica L.
Hydrolea quadrivalvis Walt.
Tecoma radicans (L.) DC.
Dianthera Americana L.
Lobelia cardinalis L.
Conoclinium coelestinum (L.) DC.
Pluchea petiolata Cass.

Polypodium and *Tillandsia* are usually epiphytes, but I have included them here because in this region they are mostly confined to river-swamps.

In non-alluvial swamps and wet woods, where the soil consists largely of humus, the flora is quite different from that just mentioned, as may be seen from the following list:

Asplenium Filix-foemina (L.) Bernh.
Osmunda regalis L.
cinnamomea L.
Arisaema triphyllum (L.) Torr.
Lilium superbum L.
Smilax laurifolia L.
Walteri Pursh.
Myrica cerifera L.
Alnus rugosa (DuRoi) Koch.
Ulmus alata Mx.
Magnolia glauca L.
Liriodendron Tulipifera L.
Itea Virginica L.
Rosa Carolina L.
Cercis Canadensis L.
Kraunhia frutescens (L.) Greene.
Apios tuberosa Moench.
Liquidambar Styraciflua L.
Rhus Vernix L.
Cyrilla racemiflora Walt.
Ilex glabra (L.) Gray.
Acer rubrum L.
Decodon verticillatus (L.) Ell.
Ludwigia pilosa Walt.
Parthenocissus quinquefolia (L.) Planch.
Aralia spinosa L.
Clethra alnifolia L.
Azalea viscosa L.
Cephalanthus occidentalis L.
Pinckneya pubens Mx.
Sambucus Canadensis L.
Viburnum nudum L.
dentatum L.
Mikania scandens (L.) Willd.

A number of species grow on the banks of creeks and rivers above the usual high-water mark which are not found in the alluvial swamps lower down. Among these are the following:

Uniola latifolia Mx.
Smilax Bona-nox L.
Salix nigra Marsh.
Betula nigra L.
Fagus Americana Sweet.
Magnolia grandiflora L.
Amelanchier Canadensis (L.) Medic.
Sebastiana ligustrina (Mx.) Müll. Arg.
Passiflora lutea L.
Kalmia latifolia L.
Styrax Americana Lam.
Catalpa bignonioides Walt.
Diodia Virginiana L.

The wet meadows of Sumter County have quite an interesting flora. The following species have been collected mostly in the meadows along Muckalee Creek in Americus:

Woodwardia areolata (L.) Moore.
Virginica (L.) J. E. Smith.
Osmunda regalis L.
cinnamomea L.
Homalocenchrus oryzoides (L.) Poll.
Cyperus strigosus L.
Kyllinga pumila Mx.
Scirpus Eriophorum Mx.
Rhynchospora glomerata paniculata (Gray) Chapm.
inexpansa (Mx.) Vahl.
Carex vulpinoidea Mx.
verrucosa Muhl.
Melanthium Virginicum L.
Lilium Catesbaei Walt.
Habenaria ciliaria (L.) R. Br.
cristata (Mx.) R. Br.
Gyrostachys praecox (Walt.) Kuntze.
Glottidium Floridanum DC.
Linum striatum Walt.
Hibiscus aculeatus Walt.
Rhexia Virginica L.
Mariana L.
Ludwigia sphaerocarpa Ell.
Oxypolis rigidus (L.) Britton.
Asclepias lanceolata Walt.
Mentha viridis L.
Mesosphaerum rugosum (L.) Pollard.
Gerardia purpurea L.
Vernonia Noveboracensis (L.) Willd.
Eupatorium purpureum L.

In sandy or sphagnous bogs are found the following species:

Lycopodium Carolinianum L.
adpressum (Chapm.) Lloyd & Underw.
Campulosus aromaticus (Walt.) Scribn.
Cyperus Haspan L.
Fuirena squarrosa hispida (Ell.) Chapm.
Carex verrucosa Muhl.
Mayaca Aubleti Mx.
Eriocaulon decangulare L.
Tofieldia racemosa (Walt.) B.S.P.
Zygadenus glaberrimus Mx.
Aletris aurea Walt.
Habenaria blephariglottis (Willd.) Torr.
Pogonia ophioglossoides (L.) Ker.
Limodorum tuberosum L.
Sarracenia rubra Walt.
Drummondii Croom.
Drosera capillaris Poir.
Pyrus arbutifolia (L.) L. f.
Polygala lutea L.
cruciata ramosior Nash.
Ascyrum stans Mx.
Hypericum fasciculatum Lam.
pilosum Walt.
Triadenum Virginicum (L.) Raf.
Rotala ramosior (L.) Koehne.
Rhexia ciliosa Mx.
Pieris nitida (Bartr.) Benth & Hook.
Cynoctonum sessilifolium (Walt.) Gmel.
Sabbatia macrophylla Hook.
Bartonia Virginica (L.) B.S.P.
Gratiola pilosa Mx.
quadridentata Mx.
Oldenlandia uniflora L.
Eupatorium perfoliatum L.
Solidago stricta Ait.
Coreopsis gladiata Walt.
Baldwinia uniflora Nutt.

In sandy soil which is too dry for a bog, but not dry enough to be loose, a number of interesting species are found. This kind of soil is frequent in the ditches along railroad tracks, and is characterized by the following species:

Pteris aquilina L.
Paspalum laeve Mx.
purpurascens Ell.
Panicum elongatum Pursh.
Cyperus pseudovegetus Steud.
Eleocharis tuberculosa R. Br.
Fimbristylis autumnalis (L.) R. & S.
Scirpus Americanus Pers.
Lipocarpha maculata (Mx.) Torr.
Xyris Caroliniana Walt.
Juncus marginatus Rostk.
scirpoides Lam.
Lilium Carolinianum Mx.
Eryngium aquaticum L.
Ptilimnium capillaceum (Mx.) Hollick.
Steironema lanceolatum (Walt.) Gray.
Sabbatia angularis (L.) Pursh.
Collinsonia anisata Sims.
Mesosphaerum rugosum (L.) Pollard.
Monniera acuminata (Walt.) Kuntze.
Ilysanthes refracta (Ell.) Benth.
Gerardia purpurea L.
Helianthus angustifolius L.
Helenium autumnale L.
Erechthites hieracifolia (L.) Raf.

Richest in number of species, particularly in Leguminosae and Compositae, are the comparatively large areas of dry loose sand. The following is a partial list of species inhabiting such areas:

Pteris aquilina L.
Pinus palustris Mill.
Andropogon furcatus Muhl.
Cenchrus echinatus L.
Cyperus retrofractus (L.) Torr.
Scleria triglomerata Mx.
pauciflora Muhl.
Commelina Virginica L.
Chrosperma muscaetoxicum (Walt.) Kuntze.
Yucca filamentosa L.
Agave Virginica L.
Castanea pumila (L.) Mill.
Quercus cinerea Mx.
Eriogonum tomentosum Mx.
Rumex hastatulus Baldw.
Froelichia Floridana (Nutt.) Moq.
Paronychia riparia Chapm.
Clematis reticulata Walt.
Sassafras officinale Nees & Eberm.
Rubus trivialis Mx.
Morongia angustata (T. & G.) Britton.
Cassia Chamaecrista L.
nictitans L.
Baptisia alba (L.) R. Br.
lanceolata (Walt.) Ell.
megacarpa Chapm.
Crotalaria rotundifolia (Walt.) Poir.
Psoralea canescens Mx.
Kuhnistera pinnata (Walt.) Kuntze.
Indigofera Caroliniana Walt.
Zornia bracteata (Walt.) Gmel.
Meibomia stricta (Pursh) Kuntze.
Lespedeza Stuvei Nutt.

Bradburya Virginiana (L.) Kuntze.
Clitora Mariana L.
Strophostyles umbellata (L.) Britton.
Dolicholus tomentosus (L.) Vail.
simplicifolius (Walt.) Vail.
erectus (Walt.) Vail.
Polygala incarnata L.
polygama Walt.
Boykinii Nutt.
grandiflora Walt.
Tragia urticaefolia Mx.
urens L.
Jatropha stimulosa Mx.
Stillingia sylvatica L.
Euphorbia cordifolia Ell.
Rhus copallina L.
Ceanothus Americanus L.
Vitis aestivalis Mx.
Ascyrum multicaule Mx.
Cfscyrum pumilum Mx.
Hypericum maculatum Walt.
Sarothra gentianoides L.
Lechea villosa Ell.
Opuntia vulgaris Mill.
Gaura Michauxii Spach.
Angelica villosa (Walt.) B.S.P.
Vaccinium arboreum Marsh.
Polypremum procumbens L.
Amsonia angustifolia (Ait.) Michx.
Apocynum cannabinum L.
Asclepias verticillata L.
amplexicaulis Smith.
tuberosa L.
Acerates viridiflora (Raf.) Eaton.
Ipomoea pandurata L.
Brewcria humistrata (Walt.) Gray.
Cuscuta arvensis Beyr.
Onosmodium Virginianum (L.) A. DC.
Verbena Caroliniana Mx.
Callicarpa Americana L.
Salvia azurea Lam.
Dicerandra linearifolia (Ell.) Benth.
Monarda punctata L.
Trichostema dichotomum L.
Physalis Virginica Mill.
Afzelia pectinata (Pursh) Kuntze.
Dasystoma flava (L.) Wood.
Virginica (L.) Britton.
Calophanes oblongifolia (Mx.) Don.
Galium hispidulum Mx.
Vernonia angustifolia Mx.
Eupatorium hyssopifolium L.
album L.
rotundifolium L.
Lacinaria elegans (Walt.) Kuntze.
scariosa (L.) Hill.
tenuifolia (Nutt.) Kuntze.
Chrysopsis Mariana (L.) Nutt.
graminifolia (Mx.) Nutt.
Isopappus divaricatus (Nutt.) T. & G.
Sericocarpus bifoliatus (Walt.) Porter.
Silphium Asteriscus L.
compositum Mx.
Berlandiera tomentosa Nutt.
Rudbeckia hirta L.
Tetragonotheca helianthoides L.
Helianthus divaricatus L.
Coreopsis major Walt.
tripteris L.
Gaillardia lanceolata Mx.
Lygodesmia aphylla (Nutt.) DC.

In South Georgia the flora of roadsides, waste places, and cultivated fields is very similar to that of the dry sand areas, and it is impossible to draw a sharp line between them. Almost any of

the sand-loving plants may be found along roadsides or in other artificial localities, but the following seem to be mostly confined to such places:

Andropogon scoparius Mx.
Syntherisma sanguinalis (L.) Krok.
Chaetochloa viridis (L.) Scribn.
Sporobolus Indicus (L.) R. Br.
Capriola Dactylon (L.) Kuntze.
Eleusine Indica (L.) Gaertn.
Dactyloctenium AEgyptiacum (L.) Willd.
Cyperus rotundus L.
Stenophyllus capillaris (L.) Britton.
Polygonum Pennsylvanicum L.
Chenopodium ambrosioides L.
Amarantus spinosus L.
retroflexus L.
Phytolacca decandra L.
Boerhaavia erecta L.
Mollugo verticillata L.
Portulaca oleracea L.
Alsine media L.
Lepidium Virginicum L.
Coronopus didymus (L.) J. E. Smith.
Cardamine hirsuta L.
Rubus nigrobaccus Bailey.
trivialis Mx.
Albizzia Julibrissin Durazz.
Cassia occidentalis L.
Tora L.
Lespedeza striata (Thunb.) H. & A.
Oxalis stricta L.
Croton glandulosus L.
Acalypha ostryaefolia Riddell.
Euphorbia Preslii Guss.
maculata L.
Modiola Caroliniana (L.) Don.
Sida spinosa L.
Passiflora incarnata L.
Onagra biennis (L.) Scop.
Hartmannia speciosa (Nutt.) Small.
Daucus pusillus Mx.
Ipomoea coccinea L.
purpurea (L.) Roth.
hederacea Jacq.
Jacquemontia tamnifolia (L.) Griseb.
Cuscuta arvensis Beyr.
Heliotropium Indicum L.
Verbena bracteosa Mx.
Lamium amplexicaule L.
Leonotis nepetaefolia R. Br.
Physalis angulata L.
Solanum nigrum L.
Carolinense L.
Datura Tatula L.
Plantago major L.
aristata Mx.
Diodia teres Walt.
Richardsonia scabra St. Hill.
Lonicera Japonica Thunb.
Erigeron Canadensis L.
Ambrosia artemisiaefolia L.
Xanthium strumarium L.
Bidens bipinnata L.
Helenium tenuifolium Nutt.
Anthemis Cotula L.
Acanthospermum australe (L.) Kuntze.
Sitilias Caroliniana (Walt.) Raf.
Lactuca Canadensis L.

It will be noticed that very few of these are European weeds. Some have been introduced from the West, some from the tropics,

and a few from Asia, but the majority are natives of Georgia. It may be worthy of note that there are very few species of troublesome weeds in this section.

The dry or rich woods which are so characteristic of Middle Georgia are of small extent in South Georgia, and comparatively few species inhabit them. In the following list of plants growing in woods I have combined both rich and dry woods, as in South Georgia the two kinds are scarcely distinguishable.

Polystichum acrostichoides (Mx.) Schott.
Uniola longifolia Scribn.
Carex triceps Mx.
Hymenocallis lacera Salisb.
Hypoxis erecta L.
Dioscorea villosa L.
Gyrostachys gracilis (Bigel.) Kuntze.
Tipularia unifolia (Muhl.) B.S.P.
Hexalectris aphyllus (Nutt.) Raf.
Quercus digitata (Marsh.) Sudw.
Phoradendron flavescens (Pursh) Nutt.
Asimina parviflora (Mx.) Dunal.
Persea Borbonia (L.) Spreng.
Hamamelis Virginiana L.
Liquidambar Styraciflua L.
Agrimonia mollis (T. & G.) Briton.
Psoralea pedunculata (Mill.) Vail.
Stylosanthes biflora (L.) B.S.P.
Meibomia nudiflora (L.) Kuntze.
Falcata comosa (L.) Kuntze.
Phaseolus polystachyus (L.) B.S.P.
AEsculus octandra Marsh.
Vitis rotundifolia Mx.
Ampelopsis arborea (L.) Rusby.
Parthenocissus quinquefolia (L.) Planch.
Sida rhombifolia L.
Aralia spinosa L.
Nyssa sylvatica Marsh.
Oxydendrum arboreum (L.) DC.
Diospyros Virginiana L.
Koellia incana (L.) Kuntze.
Dasystoma pectinata (Nutt.) Benth.
Pedicularis Canadensis L.
Epiphegus Virginiana (L.) Bart.
Ruellia strepens L.
Mitchella repens L.
Galium uniflorum Mx.
Viburnum rufotomentosum Small.
Elephantopus tomentosus L.
Solidago brachyphylla Chapm.
Hieracium Gronovii L.

All the plants mentioned so far are found outside of the pine-barren region. In the pine-barrens the flora is very different, and, to me at least, the most interesting of all.

At this point it might be well to state that the term pine-barren is a very inappropriate one, for the soil of the pine-barrens seems to be just as fertile as any other soil in the region, if not more so. This term is not used by the natives, but has been used so universally in botanical works that it has come to have a very definite meaning.

There are several kinds of pine-barrens, botanically considered. In Sumter County I have distinguished three, differing principally in the amount of water in the soil.

First are the wet pine-barrens, in which the ground is usually covered with water a few inches to a foot or so in depth. I know only one or two such places, but in them I have found the following species:

Pinus palustris Mill.
Rhynchospora corniculata (Lam.) Gray.
Tracyi Britton.
Fontederia cordata L.
Stillingia aquatica Chapm.
Ilex myrtifolia Walt.
glabra (L.) Gray.
Hypericum fasciculatum Lam.
Proserpinaca pectinata Lam.
Sabbatia decandra (see p. 432).
gentianoides Ell.
Gratiola quadridentata Mx.
Monniera Caroliniana (Walt.) Kuntze.
Utricularia purpurea Walt.
juncea Vahl.
Lobelia Nuttallii R. & S.
Sclerolepis uniflora (Walt.) B.S.P.

In the moist pine-barrens, where there is no standing water on the surface, the species are more numerous, the following being a partial list of them:

Lycopodium alopecuroides L.
Pinus palustris Mill.
Taxodium distichum imbricarium (Nutt.) Sarg.
Rottboellia rugosa Nutt.
Campulosus aromaticus (Walt.) Scribn.
Dichromena latifolia Baldw.
Rhynchospora axillaris (Lam.) Britton.
microcarpa Baldw.
Tofieldia racemosa (Walt.) B.S.P.
Aletris aurea Walt.
Gyrotheca capitata (Walt.) Morong.
Habenaria nivea (Nutt.) Spreng.
Gyrostachys praecox (Walt.) Kuntze.
Limodorum tuberosum L.
Sarracenia lacunosa Bartr.
Polygala cymosa Walt.
Ilex myrtifolia Walt.
Hypericum myrtifolium Lam.
virgatum Lam.
Rhexia glabella Mx.
Hydrocotyle repanda Pers.
Sabbatia paniculata (Mx.) Pursh.
campanulata (L.) Torr.
Acerates Floridana (Lam.) A. S. Hitchcock.
Breweria aquatica (Walt.) Gray.
Gerardia linifolia Nutt.
Trilisa odoratissima (Walt.) Cass.
Chondrophora nudata virgata (Nutt.) Britton.
Aster adnatus Nutt.
Pluchea foetida (L.) B.S.P.
Rudbeckia Mohrii Gray.
Helianthus Radula (Pursh) T. & G.
Coreopsis nudata Nutt.

Most of the herbaceous plants of moist pine-barrens have conspicuous white, yellow, or pink-purple flowers. Among those with white flowers are *Dichromena* (in this case it is the involucre that is colored), *Habenaria nivea*, and *Sabbatia paniculata;* with yellow, *Aletris*, *Gyrotheca*, *Polygala cymosa*, *Hypericum myrtifolium*, *H. virgatum*, *Chondrophora* and *Rudbeckia Mohrii*; and with pink-purple, *Limodorum*, *Rhexia*, *Sabbatia campanulata*, *Brewcria*, *Gerardia*, *Trilisa*, and *Coreopsis*. As most of these colored flowers, and several others not mentioned, can generally be found in the same locality and at the same time, it follows that these pine-barrens in summer present a very beautiful appearance; and, all things considered, they are most delightlful places for the botanist.

Lastly may be mentioned the plants of dry pine-barrens, where the surface soil consists of dry sand. These are not of great extent in Sumter County, and their flora is similar to that of the dry sandy fields already mentioned. The following is a list of some of the principal plants of dry pine-barrens:

Pteris aquilina L.
Pinus palustris Mill.
Gymnopogon ambiguus (Mx.) B.S.P.
Crotalaria Purshii DC.
Cracca Virginiana L.
Meibomia arenicola Vail.
Galactia erecta (Walt.) Vail.
Ceanothus microphyllus Mx.
Vaccinium stamineum L.
Asclepias tomentosa Ell.
Lacinaria elegans (Walt.) Kuntze.
tenuifolia (Nutt.) Kuntze.
Coreopsis lanceolata L.
delphinifolia Lam.

The four or five hundred species mentioned in the above lists probably represent less than half the number of pteridophytes and spermatophytes in Sumter County.

Below I give an annotated list of species which are little known, or are of interest on account of their distribution.

As there are very few points in this part of the State whose altitudes are known, I do not attempt to give the altitudinal distribution of each species. I will mention, however, that in the city of Americus the altitude ranges from about 300 feet along Muckalee Creek to 400 or more in the central portions of the city. The altitude of the pine-barren region, about 10 miles southeast of Americus is probably about 250 feet, and that of the Flint

River at the southeastern corner of the county, 22 miles from Americus, about 200 feet.

ADIANTUM CAPILLUS-VENERIS L. Sp. Pl. 1096. 1753

Collected at the mouth of a small limestone cave in Dooly County, near the Flint River, August 5, 1896, and July 26, 1897. This seems to be the only known station in Georgia for this rare fern.

LYCOPODIUM ALOPECUROIDES L. Sp. Pl. 1102. 1753

This species is quite common in the moist pine-barrens of Sumter County, where it seems to be the only representative of the genus.

LYCOPODIUM ADPRESSUM (Chapm.) Lloyd & Underwood, Bull. Torr. Club, **27**: 153. *pl. 3. f. 14–18.* Apr. 1900

This species resembles the preceding very much, but never grows with it, as far as I have observed. I have always found it in sandy bogs outside of the pine-barrens. *L. Carolinianum* inhabits similar localities.

TAXODIUM DISTICHUM IMBRICARIUM (Nutt.) Sargent, Sylva N. A., **10**: 152. 1896

On July 26, 1897, I found some small specimens of a *Taxodium* which is evidently referable to this variety, in pine-barrens near Cobb, about three miles west of the Flint River. Although the trees were only about 4 m. tall, they bore considerable fruit. It seems to me that this plant differs sufficiently from *T. distichum* in size, form of leaves, and especially in habitat, to be recognized as a good variety.

JUNIPERUS VIRGINIANA L. Sp. Pl. 1038. 1753

The only place in Georgia where I have seen this tree undoubtedly native is in the Flint River swamps, in Dooly County, where it attains a considerable size. In Middle Georgia it generally has the appearance of being escaped from cultivation.

ROTTBOELLIA RUGOSA Nutt. Gen. **1**: 84. 1818

Collected in moist pine-barrens in the eastern part of Sumter County, August 30, 1897, in flower. I do not find that this species has been reported from so far inland before.

PANICUM ELONGATUM Pursh, Fl. Am. Sept. 69. 1814

Not rare in rather moist sandy soil, Sumter County. Flowers in late summer. This grass does not seem to have been hitherto reported south of North Carolina. Mr. G. V. Nash has kindly identified one of my specimens, collected in Americus, Aug. 22, 1897.

ELEOCHARIS MUTATA (L.) R. & S. Syst. **2**: 155. 1817

Found growing in three or four inches of water in a wet meadow near Ellaville, Schley County, July 24, 1895. I know of no other station in Georgia for this species, and it is certainly not common.

ELEOCHARIS TUBERCULOSA (MX.) R. & S. Syst. **2**: 152. 1817

In moist sand, Americus, June, 1897. This seems to be its inland and upper altitudinal limit, as far as known, and also the first station in Georgia.

SCIRPUS ATROVIRENS Muhl. Gram. 43. 1817

On June 21, 1897, I collected a fine specimen of this species in a meadow near Muckalee Creek in Americus, thus extending its known range over 200 miles.

SCIRPUS DIVARICATUS Ell. Bot. S. C. & Ga. **1**: 88. *pl. 2. f. 4.* 1816

In alluvial soil along Muckalee Creek, Americus and northward. Not previously reported from Georgia.

RHYNCHOSPORA TRACYI Britton, Trans. N. Y. Acad. **11**: 84. 1892

Ceratoschoenus capitatus Chapm. Fl. S. States, ed. 1, 529. 1860.

Collected in wet pine-barrens in the southern part of Sumter County, July 21, 1897. This station is farther east and about 100 miles farther north and at a higher altitude than any previously known for this species, and is also the first in Georgia.

CAREX FOLLICULATA AUSTRALIS Bailey, Proc. Am. Acad. **22**: 62. 1886

Collected in muddy woods near Muckalee Creek about two miles north of Americus, with *Scirpus divaricatus*, July 3, 1897. Not previously reported from Georgia.

PONTEDERIA CORDATA L. Sp. Pl. 288. 1753.

This species seems to be very rare in Georgia. I have collected it only once, in a pine-barren pond in Sumter County, July 21, 1897. This is probably the only station now known in the State.

LILIUM SUPERBUM L. Sp. Pl. ed. 2, 434. 1762

Grows in rich deep damp woods just south of Americus. This seems to be about 150 miles south of any previously known station.

HYMENOCALLIS LACERA Salisb. Trans. Hort. Soc. **1**: 338. 1812

Collected in rich woods near DeSoto, Sumter County, July 26, 1897, in flower.

TIPULARIA UNIFOLIA (Muhl.) B.S.P. Prel. Cat. N. Y. 51. 1888

In rich woods, under the shade of *Fagus Americana* and *Magnolia grandiflora*, near Muckalee Creek, Americus. Flowers in August.

HEXALECTRIS APHYLLUS (Nutt.) Raf.; Wats. & Coult. in Gray's Man. ed. 6, 501. 1890

In rich woods, Schley and Sumter Counties, flowering in July, very rare. I have only found two or three specimens.

ERIOGONUM TOMENTOSUM Mx. Fl. Bor. Am. **1**: 246. *pl. 24.* 1803

In dry sand, along or near the Flint River, Sumter and Macon Counties, flowering in August. This species has not been reported from farther inland or at a higher altitude.

RUMEX HASTATULUS Baldw.; Ell. Bot. S. C. & Ga. **1**: 416. 1817

In dry sandy soil, Americus. Not previously reported from so far inland in the Atlantic States.

FROELICHIA FLORIDANA (Nutt.) Moq. in DC. Prodr. **13**^{2}: 420. 1849

Grows in dry sand near the Flint River, Sumter County.

PARONYCHIA RIPARIA Chapm. Fl. S. States, ed. 2, 607. 1883

On July 26, 1897, I collected in dry sand along the Flint River a *Paronychia* which I afterward determined to belong to this species, which is known only from the banks of this river. I can

find no record of the exact location of the original station, but it is no doubt farther south than mine.

CLEMATIS RETICULATA Walt. Fl. Car. 156. 1788

Common in dry sandy fields and woods about Americus, flowering from June to August.

SARRACENIA DRUMMONDII Croom, Ann. Lyc. N. Y. **4**: 100. *pl. 1.* 1848.

In sandy bogs, ranging from two miles southeast to three miles northwest of Americus; the largest and commonest species of the genus in Sumter County. I have measured specimens whose leaves and scapes were fully a meter tall. Sumter County seems to be the northern limit of this species.

SARRACENIA RUBRA Walt. Fl. Car. 152. 1788

In bogs with *S. Drummondii*, but less common, and only attaining about one fourth of the maximum dimensions of the former. This species on account of its small size and dull coloring is much more easily overlooked, and does not seem to have been collected many times.

SARRACENIA LACUNOSA Bartr. Travels, 415. 1791

S. variolaris Mx. Fl. Bor. Am. **1**: 310. 1803.

Found only in the pine-barrens, where the other two species do not occur. Bartram's description of *S. lacunosa* is sufficiently complete to leave no doubt as to what species he had in mind, and his name antedates that of Michaux by a dozen years. *S. minor* Walt. is still older, but its identity with *S. lacunosa* does not seem to have been established.

DROSERA CAPILLARIS Poir. Encyc. **6**: 299. 1804

In sandy bogs, often with the two *Sarracenias* first mentioned, flowering June to August. This is near its inland limit.

AGRIMONIA MOLLIS (T. & G.) Britton, Bull. Torr. Club, **19**: 221. 1892

In dry woods, Americus, flowering in August. This is one of its southernmost known stations.

BAPTISIA MEGACARPA Chapm.; T. & G. Fl. N. A. **1**: 376. 1838

On July 3, 1897, I found specimens of this species in fruit in dry sandy soil near Muckalee Creek, north of Americus, thus extending its known range northward about 40 miles.

PSORALEA CANESCENS Mx. Fl. Bor. Am. **2**: 57. 1803

In dry sand and dry pine-barrens in the eastern part of Sumter Co., rare. Fruits in July. This seems to be its inland and upper altitudinal limit.

AMORPHA VIRGATA Small, Bull. Torr. Club, **21**: 17. *pl. 171.* 1894

Collected, in fruit, on the bank of Gum Creek, Dooly County, July 26, 1897.

KUHNISTERA PINNATA (Walt.) Kuntze, Rev. Gen. Pl. 192. 1891

Petalostemon corymbosus Mx. Fl. Bor. Am. **2**: 50. 1803.

On Sept. 5, 1897, I collected this curious plant in dry sandy soil on the site of Andersonville Prison, Macon County. At that time its flowers had not begun to open. This seems to be the only definitely known station for it outside of Florida.

GLOTTIDIUM FLORIDANUM DC. Prodr. **2**: 266. 1825

Sebania vesicaria Ell. Bot. S. C. & Ga. **2**: 322. 1824.

Abundant in low grounds near Muckalee Creek, Americus, flowering in August and September. This is probably the highest known station for it. This plant is one of the largest annuals we have, the stem becoming about 3 meters tall and 4 cm. in diameter at the base. In the fall it becomes hard and woody, and I have cut stems in winter which could not be readily distinguished from a woody branch of the same size.

POLYGALA BOYKINII Nutt. Jour. Acad. Phila. **7**: 86. 1834

Collected in dry sandy soil near DeSoto, July 26, 1897.

STILLINGIA AQUATICA Chapm. Fl. S. States, 405. 1860

Found in a wet meadow near Ellaville, July 24, 1895, and in pine-barren ponds, Sumter County, June 26, 1897. The altitude of the former station is about 570 feet, and it is probably the northernmost known for this species.

SEBASTIANA LIGUSTRINA (Mx.) Muell. Arg. in DC. Prodr. **15**^{2}: 1165. 1862

Banks of Muckalee Creek and Flint River, Sumter County. Flowers in June.

EUPHORBIA CORDIFOLIA Ell. Bot. S. C. & Ga. **2**: 656. 1824

Collected in dry sandy fields near Andersonville, September 5, 1897. This is one of its highest and northermost stations.

CEANOTHUS MICROPHYLLUS Mx. Fl. Bor. Am. **1**: 154. 1803

Collected in dry pine-barrens near Huntington, June 26, 1897, at which time its fruit had mostly fallen. This station is on or near its northern limit.

SIDA RHOMBIFOLIA L. Sp. Pl. 684. 1753

Grows in sandy soil, in dry oak groves, Ellaville and Americus, also near Huntington. Flowers in July and August.

HIBISCUS ACULEATUS Walt. Fl. Car. 177. 1788

In wet places near Leslie, Sumter County, flowering in July and August. Northern limit?

HYPERICUM FASCICULATUM Lam. Encyc. **4**: 160. 1797

In pine-barren ponds, growing 1–1.5 meters tall. Without flowers this species strikingly resembles a small coniferous tree, with its shreddy bark, resinous sap, and linear evergreen leaves. Flowers June to August.

HYPERICUM MYRTIFOLIUM Lam. Encyc. **4**: 180. 1797

In moist pine-barrens near Huntington, flowering from June to August. Northwestern limit?

HYPERICUM PILOSUM Walt. Fl. Car. 190. 1788

Sandy bogs near Americus, flowering in August. Inland limit?

ASCYRUM PUMILUM Mx. Fl. Bor. Am. **2**: 177. 1803

Collected in sandy soil near DeSoto, July 26, 1897. This seems to be its northern limit, as far as known.

LUDWIGIA PILOSA Walt. Fl. Car. 89. 1788

Collected in wet places near Leslie, August 31, 1897. This species does not seem to have been collected so far inland before.

JUSSIAEA LEPTOCARPA Nutt. Gen. **1**: 279. 1818

In wet ditches, Americus. This seems to be its northeastern-most known station.

HARTMANNIA SPECIOSA (Nutt.) Small, Bull. Torr. Club, **23**: 181. 1896

Sparingly introduced along roads and railroads, Americus and eastward.

NYSSA UNIFLORA Wang. Beitr. Forstw. Nordam. Holz. 83. *pl. 27. f. 57.* 1787

Grows in the swamps of Muckalee Creek a mile or two below Americus. It probably does not extend much farther from the coast, in Georgia at least.

KALMIA LATIFOLIA L. Sp. Pl. 391. 1753

Forms small thickets on the banks of Muckalee Creek in Americus and a short distance south of the city, with *Magnolia grandiflora*. I know of no more southern station for this species.

FRAXINUS CAROLINIANA Mill. Gard. Dict. ed. 8, no. 6. 1788

In Muckalee Creek swamps below Americus. Inland limit?

CHIONANTHUS VIRGINICA L. Sp. Pl. 8. 1753

On muddy banks of Muckalee Creek below Americus, with *Sabal glabra*, *Quercus lyrata*, *Nyssa uniflora*, *Fraxinus Caroliniana*, etc. Here it becomes a tree 6–8 meters tall and about 3 dm. in diameter at the base, appearing very different from the shrub which represents the species in Middle Georgia. Not noticing that its leaves were opposite, I mistook this *Chionanthus* tree for a *Nyssa* for two or three years, and it appears that the same mistake has been make by collectors in other states.

CYNOCTONUM SESSILIFOLIUM (Walt.) Gmel. Syst. **2**: 443. 1791

Occurs in sandy bogs near Americus, flowering in July and August. Inland limit.

SABBATIA MACROPHYLLA Hook. Comp. Bot. Mag. **1**: 171. 1835

Grows in a sphagnous bog north of Americus, at an altitude of about 350 feet. It is accompanied by *Sarracenia rubra*, *S. Drummondii*, *Pogonia ophioglossoides*, *Polygala cruciata ramosior*, *P. lutea*, etc., and flowers in July. This is probably the highest known station for this species. It has been previously reported only from near the Gulf coast.

Sabbatia decandra (Walt.)

Chironia decandra Walt. Fl. Car. 95. 1788.

Sabbatia chloroides var. *erecta* Ell. Bot. S. C. & Ga. **1**: 286. 1817.

Sabbatia chloroides var. *stricta* Griseb. Gen. et Sp. Gent. 125. 1839; also in DC. Prodr. **9**: 50. 1845. Gray, Syn. Fl. N. A. 115. 1886.

Sabbatia dodecandra stricta Mohr, Bull. Torr. Club, **24**: 26. 1897.

Although Walter's description of this species ("flor. decemfidis colore dodecandrae, foliis linearibus, caule rigido erecto") is rather brief, still there is no other known plant in the southeastern states which answers it exactly, and as his name for the species is cited as a synonym by both Elliott and Grisebach, no hesitation is felt in taking it up here.

That it is a species distinct from *S. dodecandra* (L.) B.S.P. (*S. chloroides* Pursh) there can be no doubt after comparing specimens of the two. One important and apparently constant distinguishing character, which seems to have been hitherto overlooked, is found in the calyx-segments. These in *S. decandra* are semicircular in cross-section, and awl-shaped, while in *S. dodecandra* they are flat, and of about the same width from the base to near the apex. *S. decandra* is one of the most beautiful and conspicuous plants of the wet pine-barrens of Sumter County, where it flowers in July and August. Besides my own specimens, collected July 21, 1897, the following in the herbaria of Columbia University and the New York Botanical Garden, all from Florida, are referred here:

DUVAL CO.: *A. H. Curtiss*, July (no. 2231); near Jacksonville, *H. D. Keeler*, 1870–76, *A. H. Curtiss*, July 10, 1893 (no.

4374), July 16, 1894 (no. 5050); Baldwin, *G. V. Nash*, July 20, 1895 (no. 2250); Pablo, *L. H. Lighthipe*, July 11, 1896 (no. 372).

Between Quincy and Aspalaga, and near St. Marks, *Rugel*, July, 1843. Without definite locality or date: *Allison* (no. 329); *Chapman*.

SABBATIA GENTIANOIDES Ell. Bot. S. C. & Ga. **1**: 286. 1817

With the preceding, flowering at the same time, and with very similar flowers. Both probably reach their inland and upper altitudinal limits here.

ASCLEPIAS AMPLEXICAULIS Smith, Georgia Insects **1**: 13. *pl.* 7. 1797

A. obtusifolia Mx. Fl. Bor. Am. **1**: 115. 1803.

Grows in dry sandy soil north of Americus; not common.

ASCLEPIAS TOMENTOSA Ell. Bot. S. C. & Ga. **1**: 321. 1817

In dry pine-barrens between Huntington and Leslie, flowering in July and August. I find no record of any station farther north than this.

JACQUEMONTIA TAMNIFOLIA (L.) Griseb. Fl. Brit. W. I., 474

In sandy soil, especially in cultivated fields, Americus and eastward. This is near its northern limit.

BREWERIA AQUATICA (Walt.) Gray, Syn. Fl. N. A. **2**[1]: 217. 1878

In moist pine-barrens near Huntington, June 26, 1897. I do not find that this species has been previously reported from Georgia.

CUSCUTA COMPACTA Juss.; Choisy, Mem. Soc. Gen. **9**: 281. *pl.* 4. *f.* 2. 1841.

On various shrubs, especially about the edges of swamps, common. Flowers in September.

DICERANDRA LINEARIFOLIA (Ell.) Benth. in DC. Prodr. **12**: 243. 1848

Ceranthera linearifolia Ell. Bot. S. C. & Ga. **2**: 94. 1821.

Collected in dry sandy soil near Andersonville, Sept. 5, 1897. The place where I found this plant answers very well Elliott's de-

scription of the type locality, which is "high pine-barren ridges between the Flint and Chatahouchie rivers." The original station was probably farther south than mine however.

MESOSPHAERUM RUGOSUM (L.) Pollard, Bull. Torr. Club, **24**: 156. 1897

Hyptis radiata Willd. Sp. Pl. **3**: 84. 1081.

Grows in moist sandy places in the eastern part of Sumter County. Flowers. Northern limit?

LEONOTIS NEPETAEFOLIA R. Br. Hort. Kew. ed. 2, **3**: 409. 1811

I have found this showy weed along sandy roadsides at two or three localities north and east of Americus.

GRATIOLA QUADRIDENTATA Mx. Fl. Bor. Am. **1**: 6. 1803

In wet pine-barrens and sandy bogs, Sumter County.

GERARDIA LINIFOLIA Nutt. Gen. **2**: 47. 1818

Collected in moist pine-barrens near Huntington, Aug. 30–31, 1897, in flower. Not previously reported from Georgia.

UTRICULARIA MACRORHYNCHA Barnhart, Bull. Torr. Club, **25**: 515. 1898

Grows in wet muddy or sandy places; the commonest *Utricularia* in Sumter County. This species has been previously reported only from Florida.

EPIPHEGUS VIRGINIANA (L.) Bart. Comp. Fl. Phila. **2**: 50. 1818

Found only in "Magnolia Dell" near Muckalee Creek, Americus, under *Fagus Americana*.

CATALPA BIGNONIOIDES Walt. Fl. Car. 64. 1788

Grows on high banks of the Flint River, on the Sumter County side. There has been some uncertainty as to the native habitat of this species, but the evidence is strongly in favor of its being native in Georgia. The locality above mentioned is in a region remote from human habitations, where there are no introduced plants within many miles, so that it is extremely improbable that the *Catalpa* could have been introduced.

RICHARDSONIA SCABRA St. Hil. Pl. Us. Bres. **7**: *pl. 8*

Not rare in sandy waste places and cultivated fields, Americus.

PINCKNEYA PUBENS Mx. Fl. Bor. Am. **1**: 105. *pl. 13*. 1803

This unique and interesting shrub is quite common in non-alluvial swamps in Sumter County, and flowers in June and July. It has not previously been reported so far from the coast or at so high an altitude.

VIBURNUM DENTATUM L. Sp. Pl. 268. 1753

Grows in a swampy place near Barlow's Mill, Sumter County, where it flowers in September. This seems to be its southern limit.

LACINARIA ELEGANS (Walt.) Kuntze, Rev. Gen. Pl. 349. 1891

In dry sandy soil east and west of Americus, flowering in August and September. According to my observations the corollas in this species are invariably pure white, a fact which does not seem to have been noted before.

ASTER ADNATUS Nutt. Jour. Acad. Phila. **7**: 82. 1834

Not rare in moist pine-barrens east of Huntington. Previously known only from Florida and Alabama. The flowers of this species must be very late, for no trace of them is visible at the end of August.

RUDBECKIA MOHRII Gray, Proc. Am. Acad. **17**: 217. 1882

R. bupleuroides Shuttl.; Chapm. Fl. S. States, ed. 2, 629, 1883.

One of the characteristic plants of moist pine-barrens in the southeastern part of Sumter County, flowering from June to the end of August. This makes the third known station for this species. the other two being in West Florida, about 125 miles farther south and 200 feet lower.

HELIANTHUS RADULA (Pursh) T. & G. Fl. N. A. **2**: 321. 1842

In moist pine-barrens, flowering in September. Sumter County seems to be its northern limit, as far as known.

COREOPSIS NUDATA Nutt. Gen. **2**: 180. 1818

Collected in moist pine-barrens near Huntington, June 26, 1897, in flower. Previously known only from Florida and the adjacent coast of Georgia. The type-locality of this species is given by Nuttall as "St. Mary's, West Florida," but St. Mary's is in southeastern Georgia.

LYGODESMIA APHYLLA (Nutt.) DC. Prodr. **7**: 198. 1838

Collected in dry sand near the Flint River, in Dooly County, July 26, 1897. The type-locality and previously known range of this species are the same as in the case of *Coreopsis nudata*.

COLUMBIA UNIVERSITY.

The Erysiphaceae of Japan

By Ernest S. Salmon

(With Plate 26)

During the past eighteen months I have received from Prof. Kingo Miyabe, of the Sapporo Agricultural College, Japan, a large and well-preserved collection of Japanese Erysiphaceae, numbering 200 specimens. Most of this material is mentioned in my "Monograph of the Erysiphaceae" (3), but some of Professor Miyabe's specimens arrived too late to be included. I have also received subsequently 15 specimens from Prof. Shotaro Hori, of the Nishigahara Exper. Station, Tokio. Further, two articles have lately appeared dealing with Japanese mildews: one by H. & P. Sydow (1), in which a supposed new species of *Uncinula*, *U. Kusanoi*, is described; the other by P. Hennings (2), in which "*Phyllactinia suffulta* var. *moricola*" and "*Microsphaera Japonica*" appear. Dr. Hennings has very kindly sent me specimens of the two latter plants, and included also with them specimens of three more species from Japan under the Mss. names of *Uncinula verniciferae*, *U. Shiraiana* and *Microsphaera sambucicola*. Dr. Hennings informed me that the description of these species was already in the printer's hands, and kindly gave me permission to mention them in this paper.

To Prof. K. Miyabe and Prof. S. Hori I beg to express my thanks for the valuable material (now in Kew Herbarium) sent by them; also to Mr. P. Sydow for a specimen of *Uncinula Kusanoi*.

Before giving a full list of the species (with their host-plants and localities), known to me from Japan, a few remarks are necessary on these lately published species.

U. Kusanoi H. & P. Syd. (on *Celtis Sinensis* Pers.). Meguro pr. Tokio (leg. Kusano), has perithecia from 80–110 μ in diameter, cells of the outer wall 15–20 μ wide, appendages 10–20, usually slightly exceeding the diameter of the perithecium, but varying from 1–1½ times its diameter, often unequal in length on the same perithecium, simply uncinate at the thin-walled hyaline apex, becoming thick-walled, refractive, and often rough in the lower half,

5–6 μ wide below, 17–20 μ wide across the apex; asci 3–4, rarely 5, broadly ovate to subglobose, 45–52×35–40 μ, very shortly stalked, spores crowded, 4–6, or rarely 7, usually 6, 21–24×10–12. (See Figs. 1–12.) The authors remark (1) of the plant, "Mit keiner der bisher auf *Celtis* bekannten *Uncinula*-arten zu identifiziren"; and it is quite true that the present fungus is distinct from *U. polychaeta*, *U. parvula* and *U. confusa*. But after careful comparison I am unable to separate "*U. Kusanoi*" from *U. Clintonii* Peck. At first sight *U. Clintonii* (in perhaps its commonest form) appears distinct in the larger perithecia with more numerous longer appendages, large and more numerous asci, and especially in the much enlarged clavate apex of the appendages, often measuring 30 μ across (see Figs. 18–23). But, as I have previously pointed out (3) the enlarged apex of the appendages cannot be considered as a constant character of *U. Clintonii*. In two interesting examples of the species—one from Crawfordsville, Indiana (E. M. Fisher, Oct., 1890. Ex. Herb. U. S. Dept. Agric., no. 1055), the other from Washington, D. C. (P. Magnus, Oct., 1897) (see Figs. 13–17), we find the perithecia exhibiting all the characters of the Japanese plant.

The perithecia of these American specimens are equally small (in one case the diameter was only 70 μ) the appendages are as few, with the apex measuring 20 μ across; and the number and size of the asci and spores are the same. Until lately *U. Clintonii* had been supposed to be confined to the United States (where it is not uncommon, on the single host-plant *Tilia Americana*, in the Eastern States), but, as I have already recorded (3), two Japanese examples of a fungus on *Zelkova acuminata* and *Aphananthe aspera* sent to me by Professor Miyabe, although differing slightly from the American forms of *U. Clintonii*, approached so closely to this species as to be unable to be separated. The discovery in Japan of a form of *U. Clintonii* on *Celtis Sinensis* agreeing exactly with certain American examples on *Tilia Americana* is therefore very interesting. I have received the present species (on *Celtis Sinensis*) from Prof. S. Hori (Tokio, Akabane, Oct. 15, 1899; coll. Nishida & Nambu).

Phyllactinia suffulta var. *moricola* P. Henn. Following the description the author remarks: "Diese Varietät ist von der Typ-

ischen Art schon äusserlich durch das dickfilzige, weisse bis gelbliche Mycel gut verschieden." In the specimen sent (on *Morus alba*, Tokio, leg. Miyoshi), the mycelium is persistent in a thin effused coat, but, as I have already shown (3), it isimpossible to regard the persistence or evanescence of the mycelium in the Erysiphaceae as a systematic character of the first importance. In certain examples of *P. corylea* (*P. suffulta*) on *Corylus* from Europe, and on *Quercus* from North America, the mycelium is frequently persistent just as in the Japanese plant, but no characters are shown of sufficient weight to separate the plants in any way from the type. It is interesting to find that in a specimen of *P. corylea*, sent to me by Professor Miyabe, on the same host (*Morus alba*) fromSapporo (E. Tokubuchi) the mycelium is perfectly evanescent. *Microsphaera sambucicola* P. Henn. ("on *Sambucus*, Japan") is *M. grossulariae*. This is the form of the species which was described by Gerard, from American specimens on *Sambucus Canadensis*, as *M. Van Bruntiana*, but which has been correctly referred to *M. grossulariae* by Burrill (Ell. & Everh. N. Amer. Pyren., p. 24).

Microsphaera Japonica P. Henn. (on *Cornus macrophylla*, Tokio). The author remarks (2) "Die Art ist von *M. pulchra* C. et Peck durch 8-sporige, eiförmige Asken durch die spitzen Enden der Anhängsel u. s. w. verschieden, derselben aber nahe stehend." I have already (3) referred this Japanese plant to *M. alni*, and also shown that "*M. pulchra*"—which is a more extreme form than the present plant cannot possibly be maintained as distinct. From the description given in the diagnosis (2) it would appear that the appendages were observed in an immature condition. The apex of a mature appendage is shown at Fig. 24. Comparison of this figure with those I have given (3) of the appendages of *M. alni* will show the identity of the Japanese plant.

Uncinula Shiraiana P. Henn. (on *Celtis Sinensis*, Tokio) is *U. polychaeta*. I had already seen examples of this fungus on the same host from Tokio, Sugamo (S. Hori). In these latter specimens the asci are 2-, or more often 3-spored, in Dr. Hennings' plant the asci are usually 3-spored, sometimes 2- or 4-, or very rarely 5-spored. In examples of the species from America the spores are almost constantly 2 in number, and the peculiarity of the

Chinese and Japanese specimens in having usually more spores has already been remarked (3). Tracy and Galloway, however, have recorded (Bot. Gaz. **13**: 29–32. 1888) the occurrence of 3 and 4 spores in the ascus in some American specimens.

U. verniciferae P. Henn. (on *Rhus vernicifera*, Tokio). The specimen sent is too immature to enable me to give a full description of the plant. It appears, however, a distinct species, showing affinity with *U. Sengokui*, but differing in the thicker-walled appendages, slightly narrowed upwards to the closely coiled frequently helicoid apex.

Dr. Hennings has also sent me an interesting form of *Erysiphe polygoni* on *Actinostemma racemosum*. This is remarkable in having the perithecia more or less imbedded in the persistent mycelium. Similar forms occur in Japan on *Diervilla Japonica* and *Paeonia obovata*.

The example of *M. alni* sent by Professor Hori on *Styrax Japonicum* from Tokio, Akabane (coll. Nambu and Nishida) is instructive in showing the variation that occurs in this species in the mode of branching of the apex of the appendages. In this specimen appendages may be found on the same perithecium with long or short primary branches (Figs. 25 and 26).

The occurrence of *Uncinula salicis* var. *Miyabei* on *Tilia Miqueliana* is extremely interesting. The specimen was sent by Professor Miyabe, from Hokkaido, Prov. Ishikari, Shintotsugawa (coll. T. Kawakami) and agrees well with the original examples on *Alnus incana* and *A. maritima*. Professor Hori has sent specimens on the last named host from Tokio, Todamura under the MSS. name of *Uncinula aggregata*. It is possible that the present plant will prove to be specifically disinct from *U. salicis*.

I give below the distribution of the species of the Erysiphaceae occurring in Japan.

Erysiphe cichoracearum.—Europe (throughout); Africa (Algeria, Egypt); Asia (Persia, Turkestan, Siberia (Minussinsk)); New Zealand; North America (United States (throughout) and Canada (Ontario, New Brunswick, Newfoundland)).

E. galeopsidis.—Europe (throughout); Asia (Turkestan, Siberia (Minussinsk)); North America (United States (throughout) and Canada (Ontario, Newfoundland)).

E. graminis.—Europe (throughout); Africa (Algeria); Asia (Cyprus, Transcaucasia, Persia, Turkestan, Siberia (Minussinsk)); Australia (South, Victoria and New South Wales); North America (United States (throughout) and Canada (Ontario, Newfoundland)).

E. polygoni.—Europe (throughout); Africa (Canaries, Algeria); Asia (Transcaucasia, Turkey, Persia, Turkestan, India, Siberia (Minussinsk)); Australia (Victoria); New Zealand; North America (United States (throughout) and Canada (Manitoba, Ontario, New Brunswick)).

Microsphaera alni.—Europe (throughout); Asia (Transcaucasia); North America (United States (throughout) and Canada (Manitoba, Ontario, New Brunswick)).

M. berberidis.—Europe (throughout); Asia (Cyprus, Transcaucasia, Turkestan).

M. grossulariae.—Europe (throughout); North America (United States (throughout)).

Phyllactinia corylea.—Europe (throughout); Africa (Algeria); Asia (Transcaucasia, Turkey, Siberia (Minussinsk), China (Yunnan)); North America (United States (throughout) and Canada (Ontario, Newfoundland); Central America (Guatemala); South America (Paraguay, Patagonia).

Podosphaera leucotricha.—Europe (probably widely spread; recorded from Germany, Austria-Hungary and Russia); North America (United States (Vermont, Wisconsin, Iowa, Missouri, Kansas, Mississippi)).

P. oxyacanthae.—Europe (throughout); Africa (Algeria); Asia (Siberia (Minussinsk)); North America (United States (throughout), and Canada (Ontario, New Brunswick), Greenland.

P. oxyacanthae var. *tridactyla*.—Europe (throughout); North America (Washington (State)).

Sphaerotheca humuli.—Europe (throughout); Africa (Algeria); Asia (Transcaucasia, Turkestan, Siberia (Minussinsk)); North America (United States (throughout), and Canada (Ontario, New Brunswick, Newfoundland).

S. humuli var. *fuliginea*.—Europe (throughout). Asia (Turkestan, Siberia (Minussinsk)); North America (United States (throughout), and Canada (Ontario, New Brunswick)).

Uncinula aceris.—Europe (throughout); Asia (Transcaucasia).

U. australiana.—Australia (New South Wales).

U. clandestina.—Europe (not recorded farther east than Austria-Hungary and Poland); Africa (Algeria).

U. Clintonii.—North America (United States, widely spread in the Eastern States, but not recorded further west than Minnesota).

U. necator.—Europe (widely spread in the conidial state (*Oidium Tuckeri*), perithecia recorded from France only); North America (United States (throughout) and Canada (Ontario), with perithecia).

U. polychaeta.—Asia (China, (Yunnan)); North America (United States (South Carolina, Alabama, Mississippi)); South America (Argentine (Buenos Ayres)).

U. salicis.—Europe (throughout); Asia (Transcaucasia, India, Siberia (Minussinsk), China (Yunnan)); North America (United States (throughout)) and Canada (Ontario, Quebec).

According to their distribution the Japanese species may be arranged in the following six classes:

1. Cosmopolitan species: *Erysiphe cichoracearum, E. galeopsidis, E. graminis, E. polygoni, Microsphaera alni, Phyllactinia corylea, Podosphaera oxyacanthae, Sphaerotheca humuli* and var. *fuliginea, Uncinula salicis.*

2. European and North American species, recorded in Asia from Japan only: *Microsphaera grossulariae, Podosphaera leucotricha, P. oxyacanthae* var. *tridactyla, Uncinula necator.*

3. Old World species (*a*) European and Asiatic: *Microsphaera berberidis, Uncinula aceris;* (*b*) European and African: *Uncinula clandestina.*

4. American species: *Uncinula Clintonii* (United States (Eastern States)); *U. polychaeta* (found in China also) (United States (Eastern States) and South America).

5. Australian species: *Uncinula australiana.*

6. Species known only from Japan: *Uncinula fraxini, U. Sengokui, U. salicis* var. *Miyabei* (see also *U. verniciferae*, p. 440).

The following is an alphabetical list of the Japanese species, with their host-plants and localities. Appended to this is a host index.

ERYSIPHE CICHORACEARUM DC.

On *Laportea bulbifera*, Yoichi, Prov. Shiribeshi (G. Yamada); on *Plantago Kamtschatica* Zenibako, Prov. Shiribeshi, and Shiriuchi, Prov. Oshima (K. Miyabe); on *P. major* var. *Asiatica*, Sapporo (K. Miyabe), Zenibako, Prov. Shiribeshi, and Saruru, Prov. Hidaka (E. Tokubuchi), Otaru, Prov. Shiribeshi (T. Nishida), Satsukari, Prov. Oshima, and Wakkanai, Prov. Kitami (K. Miyabe); on *Artemisia vulgaris*, Sapporo (K. Miyabe & E. Tokubuchi), Otaru, Prov. Shiribeshi (T. Nishida), Kamoikotan, Prov. Ishikari (K. Miyabe); on *A. Japonica*, Sapporo (E. Tokubuchi & T. Nishida).

E. GALEOPSIDIS DC.

On *Lamium album*, Inantoge, Prov. Shiribeshi (G. Yamada), Morioka, Prov. Rikuchu (Y. Takahashi), Sapporo (Y. Tokubucho & K. Miyabe), Satsukari and Taniyoshi, Prov. Oshima (K. Miyabe); on *Chelonopsis moschata*, Shikabe, Prov. Oshima (K. Miyabe), Ozawamura, Prov. Shiribeshi (G. Yamada); on *Stachys aspera* var. *Japonica*, Sapporo (E. Tokubuchi), Sunagawa, Prov. Ishikari (K. Miyabe).

E. GRAMINIS DC.

On *Hordeum vulgare*, Kyoto (N. Hiratsuka), Sapporo (G. Yamada & N. Hiratsuka), Mombetsu, Prov. Iburi and Iwanai, Prov. Shiribeshi, Hokkaido (G. Yamada); Tokio, Nishigahara (S. Hori), Hondō, Prov. Owari, Chita (Tokubuchi).

E. POLYGONI DC.

On *Elsholtzia cristata*, Sapporo (K. Miyabe, G. Yamada & E. Tokubuchi); on *Scutellaria scordiifolia*, Sapporo (K. Miyabe); on *Aconitum Fischeri* (*A. Kamtschaticum*), Toshimoi, Etrup Isl., Kuriles (T. Kawakami), Saruru, Prov. Hidaka, Hokkaido (E. Tokubuchi), Zenibako, Prov. Shiribeshi, Hokkaido (K. Miyabe); on *Polygonum aviculare*, Zenibako, Prov. Shiribeshi (K. Miyabe), Sapporo (G. Yamada); on *Fagopyrum esculentum*, Sapporo (G. Yamada), on *Pilea stipulosa* (*P. petiolaris*), Sapporo (K. Miyabe); on *Saxifraga cortusaefolia*, Sapporo (E. Tokubuchi); on *Diervilla Japonica*, Sapporo (N. Hiratsuka & K. Miyabe); on *Paeonia obovata*, Sapporo (E. Tokubuchi & K. Miyabe); on *Thalictrum minus* var. *elatum*, Abashiri, Prov. Kitami, Hokkaido (K. Miyabe); on *T. aquilegifo-*

lium, Okushiri Island, Hokkaido (K. Miyabe); on *Clematis fusca* var. *Yezoensis*, Sorachibuto, Prov. Ishikari, Hokkaido (K. Miyabe); on *Amphicarpaea Edgeworthii*, var. *Japonica*, Nagasaki (G. Kurosawa), Otaru, Prov. Shiribeshi and Sapporo (K. Miyabe), Tokio, Akabane (S. Hori); on *Astragalus reflexistipulus*, Sapporo, Hokkaido (K. Miyabe); on *Vicia Cracca*, Sapporo (K. Miyabe), Obashiri, Prov. Kitami, Hokkaido (K. Miyabe), Abuta, Prov. Iburi, Hokkaido (K. Miyabe), Ishizaki, Prov. Oshima, Hokkaido (K. Miyabe); on *Peucedanum terebinthaceum*, Sapporo (E. Tokubuchi); on *Caucalis Japonica*, Mombetsu, Prov. Iburi, Hokkaido (K. Miyabe), Sapporo (E. Tokubuchi); on *Vicia unijuga*, Sapporo (E. Tokubuchi & G. Yamada); on *Caltha palustris*, Kutchau, Prov. Iburi, Hokkaido (G. Yamada); on *Quercus glauca*, Kyoto (T. Nishida); on *Sedum Telephium* var. *purpureum*, Sapporo (cult.) (G. Yamada).

MICROSPHAERA ALNI (Wallr.) Salm.

On *Corylus rostrata* var. *Mandshurica*, Otaru, Prov. Shiribeshi, Hokkaido (K. Miyabe & E. Tokubuchi); on *Quercus dentata*, Sapporo (K. Miyabe & G. Yamada); on *Q. crispula*, Sapporo (K. Miyabe), Noboribetsu, Prov. Iburi (T. Kawakami); on *Alnus incana*, near Morioka, Prov. Rikuchu (Y. Takahashi); on *Cornus macrophylla*, Makomonoi, near Sapporo (K. Miyabe), Utashinai, Prov. Ishikari (E. Tokubuchi); on *Picrasma quassioides* (*P. ailanthoides*), Sapporo (N. Hiratsuka, Y. Takahashi & G. Yamada); on *Castanea vulgaris* var. *Japonica*, Temya and Otaru, Prov. Shiribeshi, Hokkaido (K. Miyabe), Sapporo (E. Tokubuchi), Morioka, Prov. Rikuchu (Y. Takahashi); on *Ligustrum medium*, Sapporo (E. Tokubuchi); on *Syringa Amurensis* var. *Japonica*, Chubetsu, Prov. Ishikari (K. Miyabe); on *Schizandra Chinensis*, Sapporo (K. Miyabe & E. Tokubuchi); on *Styrax Japonicum*, Tokio, Akabane (Nambu & Nishida).

M. BERBERIDIS (DC.) Lév.

On *Berberis vulgaris*, Esashi, Prov. Oshima (K. Miyabe), Okushiri Isl., Hokkaido (K. Miyabe), Samani, Prov. Hidaka, Hokkaido (E. Tokubuchi).

M. GROSSULARIAE (Wallr.) Lév.

On *Sambucus racemosa*, Tokio, Akabane (Nishida & Nambu); on *S. racemosa* var. *pubescens*, Abuta, Prov. Iburi (K. Miyabe), Sapporo (G. Yamada).

PHYLLACTINIA CORYLEA (Pers.) Karst.

On *Amelanchier Asiatica*, Ujina, by the Inland Sea (H. Kawakami); on *Magnolia Kobus*, Sapporo (G. Yamada & E. Tokubuchi), Tokio (S. Hori); on *Actinidia arguta*, Sapporo (E. Tokubuchi & G. Yamada); on *Broussonetia papyrifera*, Komaba, Tokio (K. Sengoku); on *Hamamelis Japonica*, near Morioka, Prov. Rikuchu (Y. Takahashi); on *Betula alba*, Sapporo (N. Hiratsuka); on *Alnus incana*, Sapporo (G. Yamada); on *A. incana* var. *glauca*, Tokio, Komaba (S. Hori); on *A. maritima* (*A. Japonica*), Sapporo (K. Miyabe), Saitama-Ken, Omiya (S. Hori); on *Paulownia imperialis*, Hirosaki, Prov. Rikuoku (N. Hiratsuka), Matsuyama, Prov. Iyo, Isl. Shakoku (K. Okudaira), Saitama-Ken, Urawa (S. Hori); on *Morus alba*, Sapporo (E. Tokubuchi) (K. Miyabe), Shinotsu, Prov. Ishikari (G. Yamada), Tokio (S. Hori); on *Fraxinus Mandshurica*, Sapporo (N. Hiratsuka).

PODOSPHAERA LEUCOTRICHA (Ell. & Everh.) Salm.

On *Pyrus Sieboldi* (*P. Toringo*), Sapporo (K. Miyabe).

P. OXYACANTHAE (DC.) de Bary

On *Spiraea betulifolia*, Sapporo (Bot. Gardens) (K. Miyabe).

P. OXYACANTHAE var. TRIDACTYLA (Wallr.) Salm.

On *Prunus communis*, Sapporo (G. Yamada & E. Tokubuchi) Otaru, Prov. Shiribeshi, Hokkaido (K. Miyabe).

SPHAEROTHECA HUMULI (DC.) Burr.

On *Epilobium* sp., Etrup Isl., Kuriles (T. Kawakami); on *E. cephalostigma*, Ozawamura, Prov. Shiribeshi (G. Yamada); on *Potentilla fragarioides*, Samani, Prov. Hidaka, Hokkaido (E. Tokubuchi), Kumaishi, Prov. Oshima, Yozo (K. Miyabe), Sapporo (K. Miyabe), on *Spiraea Kamtschatica*, Sapporo (K. Miyabe), Garugawa, Prov. Ishikari (K. Miyabe), Shiriuchi, Prov. Oshima, Hokkaido (K. Miyabe); on *S. Aruncus*, Sapporo (K. Miyabe);

on *Poterium tenuifolium*, and var. *album*, Sapporo (K. Miyabe); on *P. officinale* var. *carneum*, Saruru, Prov. Hidaka, Hokkaido (E. Tokubuchi), Sapporo (K. Miyabe); on *P. Canadense* var. *medium*, Zuwosan, Prov. Iwaki (K. Miyabe); on *Geranium Nepalense*, Kami-iso, Prov. Oshima, Hokkaido (K. Miyabe); on *Agrimonia Eupatoria*, Mombetsu, Prov. Iburi, Hokkaido (K. Miyabe), Sapporo (G. Yamada); on *Spiraea Thunbergii*, Morioka, northern part of Main Island, Hondo (Y. Takahashi).

S. HUMULI var. FULIGINEA (Schlecht.) Salm.

On *Ajuga ciliata*, Sapporo (E. Tokubuchi); on *Calamintha Chinensis*, Sapporo (K. Miyabe); on *Siegesbeckia orientalis*, Sapporo (Takahashi & Hiratsuka); on *Cnicus Weyrichii* var. *Grayanum*, Sapporo (G. Yamada); on *Carpesium abrotanoides*, Sapporo (G. Yamada); on *Arctium majus*, Sapporo (K. Miyabe & E. Tokubuchi); on *Lactuca Raddiana*, Sapporo (K. Miyabe); on *Impatiens Noli-tangere*, Sapporo (E. Tokubuchi & K. Miyabe); on *I. Textori*, Sapporo (K. Miyabe & G. Yamada); on *Adenocaulon bicolor* (*A. adhaerescens*), Saruru, Prov. Hidaka, Hokkaido (E. Tokubuchi), Abuta, Prov. Iburi, Hokkaido (K. Miyabe); Sapporo (G. Yamada); on *Lactuca brevirostris* (*L. squarrosa*), Morioka, Prov. Rikuchu (Y. Takahashi); on *Fatoua pilosa* var. *subcordata*, Nagasaki (G. Kurosawa).

UNCINULA ACERIS (DC.) Sacc.

On *Acer pictum*, Sapporo (G. Yamada & K. Miyabe), Sugamo, Tokio (S. Hori); on *A. spicatum* var. *Ukuruduense* (G. Yamada).

U. AUSTRALIANA McAlp.

On *Lagerstroemia Indica*, Tokio (S. Hori); Sendai (K. Miyabe & K. Sengoku), Nishigahara, Tokio (S. Hori).

U. CLANDESTINA (Biv. Bern.) Schroet.

On *Ulmus campestris*, Sapporo (Takahashi & Hiratsuka); on *U. parviflora*, Hondo, Prov. Mino, Gifu (E. Tokubuchi).

U. CLINTONII Peck

On *Aphananthe aspera*, Tokio (K. Sengoku & K. Miyabe); on *Zelkova acuminata* (*Z. Keaki*), Kobe (K. Miyabe); on *Celtis Sinensis*, Tokio, Akabane (Nishida & Nambu).

U. FRAXINI Miyabe MSS. Salm.

On *Fraxinus longicuspis*, Sapporo (K. Miyabe).

U. NECATOR (Schwein.) Burr.

On *Actinidia polygama*, Okushiri Isl., Prov. Shiribeshi, Hokkaido (K. Miyabe), Samani Sando, Prov. Hidaka, Hokkaido (E. Tokubuchi); on *A. arguta*, Sapporo (K. Miyabe); on *A. Kolomikta*, Yubari, Prov. Ishikari, Hokkaido (E. Tokubuchi).

U. POLYCHAETA (Berk. & Curt.) Ell.

On *Aphananthe aspera*, Tokio (K. Sengoku), Hondo, Gifu (E. Tokubuchi); on *Celtis Sinensis*, Tokio, Sugamo (S. Hori).

U. SALICIS (DC.) Karst.

On *Salix viminalis*, Sapporo (E. Tokubuchi); on *S. daphnoides* (*S. acutifolia*), Sapporo (E. Tokubuchi); on *S. stipularis*, Sapporo (E. Tokubuchi); on *S. Caprea*, Sapporo (G. Yamada); on *S. Urbaniana*, Sapporo (N. Hiratsuka); on *S. gracilistyla* (*S. Thunbergiana*), Shibuya, Tokio (S. Hori); on *Populus balsamifera*, Sapporo (K. Miyabe); on *P. suaveolens*, Sapporo (K. Miyabe); on *P. tremula*, Abashiri, Prov. Kitami, Hokkaido (J. Tanaka).

U. SALICIS var. MIYABEI Salm.

On *Alnus incana*, Sapporo (G. Yamada); on *A. maritima* (*A. Japonica*), Sapporo (K. Miyabe), Tokio, Todamura (S. Hori); on *Tilia Miqueliana*, Hokkaido, Prov. Ishikari, Shintotsugawa (T. Kawakami).

U. SENGOKUI Salm.

On *Celastrus articulatus*, Komaba, Tokio (K. Sengoku).

HOST INDEX

Acer pictum, spicatum var. Ukuruduense.....U. aceris.
Aconitum Fischeri (Kamtschaticum).....E. polygoni.
Actinidia arguta.....P. corylea and U. necator.
A. Kolomikta, polygama.....U. necator.
Actinostemma racemosum.....E. polygoni.
Adenocaulon bicolor (adhaerescens).....S. humuli var. fuliginea.
Agrimonia Eupatoria.....S. humuli.
Ajuga ciliata.....S. humuli var. fuliginea.
Alnus incana.....U. salicis var. Miyabei, M. alni and P. corylea.

A. incana var. glauca ..... P. corylea.
A. maritima (Japonica) ..... P. corylea and U. salicis var. Miyabei.
Amelanchier Asiatica ..... P. corylea.
Amphicarpaea Edgeworthii var. Japonica ..... E. polygoni.
Aphananthe aspera ..... U. polychaeta and U. Clintonii.
Arctium majus ..... S. humuli var. fuliginea.
Artemisia Japonica, vulgaris ..... E. cichoracearum.
Astragalus reflexistipulus ..... E. polygoni.
Berberis vulgaris ..... M. berberidis.
Betula alba ..... P. corylea.
Broussonetia papyrifera ..... P. corylea.
Calamintha Chinensis ..... S. humuli var. fuliginea.
Caltha palustris ..... E. polygoni.
Carpesium abrotanoides ..... S. humuli var. fuliginea.
Castanea vulgaris var. Japonica ..... M. alni.
Caucalis Japonica ..... E. polygoni.
Celastrus articulatus ..... U. Sengokui.
Celtis Sinensis ..... U. Clintonii and U. polychaeta.
Chelonopsis moschata ..... E. galeopsidis.
Clematis fusca var. Yezoensis ..... E. polygoni.
Cnicus Weyrichii var. Grayanum ..... S. humuli var. fuliginea.
Cornus macrophylla ..... M. alni.
Corylus rostrata var. Mandshurica ..... M. alni.
Diervilla Japonica ..... E. polygoni.
Elsholtzia cristata ..... E. polygoni.
Epilobium cephalostigma ..... S. humuli.
Fagopyrum esculentum ..... E. polygoni.
Fatoua pilosa var. subcordata ..... S. humuli var. fuliginea.
Fraxinus longicuspis ..... U. fraxini.
F. Mandshurica ..... P. corylea.
Geranium Nepalense ..... S. humuli.
Hamamelis Japonica ..... P. corylea.
Hordeum vulgare ..... E. graminis.
Humulus Lupulus ..... S. humuli.
Impatiens Balsamina, Noli-tangere, Textori ..... S. humuli var. fuliginea.
Lactuca brevirostris (squarrosa), Raddiana ..... S. humuli var. fuliginea.
Lagerstroemia Indica ..... U. australis.
Lamium album ..... E. galeopsidis.
Lapartea bulbifera ..... E. cichoracearum.
Ligustrum medium ..... M. alni.
Magnolia Kobus ..... P. corylea.
Morus alba ..... P. corylea.
Paeonia obovata ..... E. polygoni.
Paulownia imperialis ..... P. corylea.
Peucedanum terebinthaceum ..... E. polygoni.
Picrasma quassioides ..... M. alni.

Pilea stipulosa (petiolaris) ..... E. polygoni.
Plantago Kamtschatica, major var. Asiatica ..... E. cichoracearum.
Polygonum aviculare ..... E. polygoni.
Populus balsamifera, suaveolens, tremula ..... U. salicis.
Potentilla fragarioides ..... S. humuli.
Poterium Canadense var. medium, officinale var. carneum, tenuifolium and var. album ..... S. humuli.
Prunus communis ..... P. oxyacanthae var. tridactyla.
Pyrus Sieboldi (Toringo) ..... P. leucotricha.
Quercus crispula, dentata ..... M. alni.
Q. glauca ..... E. polygoni.
Rhus vernicifera ..... U. verniciferae (see p. 440).
Salix Caprea, daphnoides, gracilistyla, purpurea, stipularis, Urbaniana, viminalis ..... U. salicis.
Sambucus racemosa and var. pubescens ..... M. grossulariae.
Saxifraga cortusaefolia ..... E. polygoni.
Schizandra Chinensis ..... M. alni.
Scutellaria scordiifolia ..... E. polygoni.
Sedum Telephium var. purpureum ..... E. polygoni.
Siegesbeckia orientalis ..... S. humuli var. fuliginea.
Spiraea Aruncus ..... S. humuli.
S. betulifolia ..... P. oxyacanthae.
S. Kamtschatica, Thunbergii ..... S. humuli.
Stachys aspera var. Japonica ..... E. galeopsidis.
Styrax Japonicum ..... M. alni.
Syringa Amurensis var. Japonica ..... "
Thalictrum aquilegifolium, minus var. elatum ..... E. polygoni.
Tilia Migueliana ..... U. salicis var. Miyabei.
Ulmus campestris, parvifolia ..... U. clandestina.
Vicia Cracca, unijuga ..... E. polygoni.
Zelkova acuminata (Keaki) ..... U. Clintonii.

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Explanation of Plate 26

(Unless otherwise stated, all figures are magnified 400 times.)

FIGS. 1–12. *Uncinula Kusanoi* H. & P. Syd., from an authentic specimen; 1, 2, perithecia, × 150; 3, cells of outer wall of perithecium; 4–7, appendages; 8–10 asci; 11, 12, spores.

FIGS. 13, 14. *U. Clintonii* Peck, from specimens collected at Crawfordsville, Ind., U. S. A. (E. M Fisher) (Ex Herb. U. S Dept. Agric., no. 1055); 13, perithecium, × 150; 14, appendage.

FIGS. 15–17. *U. Clintonii* Peck, from specimens collected at Washington, D. C. (P. Magnus); 15, perithecium, × 150; 16, appendage; 17, ascus.

FIGS. 18–23. *U. Clintonii* Peck, from specimens collected at Winona, Minn. (J. M. Holzinger) (Ex Herb. U. S. Dept. Agric.); 18, perithecium, × 150; 19–22, appendages; 23, ascus and spores.

FIG. 24. *Microsphaera Japonica* P. Henn.; apex of mature appendage.

FIGS. 25, 26. *M. alni* (Wallr.) Salm., from specimens collected at Akabane, Tokio (Nambu & Nishida) on *Styrax Japonicum;* apex of two appendages from the same perithecium.

The Development of the Karyokinetic Spindle in Vegetative Cells of Higher Plants

By Amanda McComb

(With Plates 24 and 25)

Until recent years very little was known in regard to the development of the nuclear spindle in higher plants. The commonly accepted view, that the karyokinetic spindle arose through the instrumentality of centrosomes or centrospheres was shown to be incorrect by the researches of Mottier ('97) and Osterhaut ('97) upon spore-mother cells of certain higher plants. This discovery gave an impetus to the study of karyokinesis in vegetative cells, and during the last few years a number of observers have devoted their entire attention to this subject.

Nemec ('98) who has recently published an account of the origin of the spindle in vegetative cells states, that when the chromatin thread divides into chromosomes a hyaline court appears about the nucleus. In *Allium cepa* it is never of uniform width around the nucleus, but it is broader on the sides turned towards the poles of the future spindle.

This court is sharply differentiated from the surrounding cytoplasm by a definite membrane. When the chromosomes are assuming an equatorial position this membrane begins to disappear. In this hyaline space or court central spindle fibers originate, while the peripheral fibers owe their origin to the membrane.

"Zu der selben Zeit," to use his exact words, "wo der Kernfaden in die Chromosomen zerfällt, erscheint um den Kern herum ein hyaliner Hof, der jedoch zunächst an den Polen der Theilungsachse sicher zu constatiren ist (l. c., Fig. 34, Taf. III.). Der Hof ist gegen die ihn umgebende Plasmaansammlung scharf abgegrenzt. * * * Dasselbe scheint auch seine eigene Membran zu besitzen (l. c., 34, Taf. III.), die jedoch im Stadium wo sich die Chromosomen zur Aequatorialstellung umzulagern beginnen, verschwindet."

"Die Spindelanlage tritt ueberall als ein hyalines, den kern umgebendes Gebilde auf, das an den Polenkappenförmig geformt ist."

The mantle fibers, which, according to the same observer, are first noted with the appearance of the hyaline court, arise in the cytoplasm immediately surrounding the court. These fibers grow gradually from the poles and on reaching the cell walls fasten themselves there.

Soon after the appearance of Nemec's paper, Hof ('98) published an account of his researches in an article entitled "Histologische Studien an Vegetationspunkten."

He found nothing that indicated the origin of the nuclear spindle until at the time of the segmentation of the chromatin thread. When first noted the spindle anlage, according to Hof, has the appearance of caps of kinoplasmic fibers at two diametrically opposite points on the outer surface of the nucleus. These kinoplasmic fibers, which he calls the pole caps, from their reaction toward reagents, show themselves to be the beginning of the nuclear spindle.

These caps take the form of a sharply pointed cone in the inner part of which are delicate threads that are fastened to the nuclear wall and converge to one point, whereby a bipolar spindle is formed.

Not until the chromatin thread is segmented into the chromosomes does he observe any indication of the karyokinetic spindle. "Auf die Längspaltung der chromatischen Elemente des Fadens folgt auch seine Segmentirung in Chromosomen. Diese treten auseinander und platten sich noch mehr ab, wobei aber die Chromatin spaltung wie der unkenntlich wird und der Faden sich gleichmässig tingirt. Die Kernwandung ist noch immer unverändert vorhanden. Im Gegensatz hierzu fand Mottier, das bei der vegetativen Theilung der *Liliaceen* der Chromatin faden zur Zeit, wo die Kernnandung als solche verschwindet, und die Spindelfasern in die Kernhöhle eintreten noch nicht in seine Segmente getheilt sei. In sammtlichen von mir untersuchten Objecten verhielt sich das, wie, eben angeführt wurde, anders.

Bis in das geschilderte Stadium hinein, war an meinen Objecten, weder ausserhalb noch innerhalb die Andeutung einer Spindelanlage zu finden.

Hierauf erst werden gleichzeitig an zwei diametral-entgegenstehenden Punkten der Kernoberfläche, ihr kappenförmig aufsitzend, kinoplasmatische Ansammlungen kenntlich, * * * Dis Fasern convergiren gewöhnlich alle nach einem Punkt, dem Pol der Kappe; die Spindel-Anlage ist als dann worklich bipolar."

According to Shaffner ('98) in his paper on karyokinesis in root tips of *Allium cepa*, "The division begins with the separation of the centrospheres, and when these have moved apart nearly 180° the incept (anlage) of the achromatic spindle appears, forming two dome-shaped projections on opposite sides of the nucleus, at the summits of which centrospheres are situated, forming the poles around which are cytoplasmic radiations."

"These centrospheres gradually extend outwards, drawing the spindle into a sharp pointed bipolar structure." "The incept of the spindle is very sharply differentiated from the surrounding cytoplasm and the space between it and the nuclear membrane appears very clear and transparent, like the achromatin of the nucleus."

The mantle fibers he regards as streams of cytoplasm which have nothing to do directly with the formation of the spindle.

In a study of nuclear division in the root-tip of *Allium cepa*, *Vicia faba* and *Erythronium Americanum* my observations have shown that in many cases, at least, certain very early stages in the development of the spindle have been overlooked by the three observers just cited.

The material for this study was prepared according to the method used by Mottier ('97) in his studies of *Lilium*.

In the earliest stages observed by me the fibers which take part in the formation of the spindle are comparatively few, and difficult to differentiate from the remaining cytoplasm.

In some cases at least the spindle anlage takes its origin in a delicate kinoplasmic weft surrounding the nucleus, rather than within a clear space or court formed about the nucleus. Figs. 1 and 2 represent two very early stages. In Fig. 1 the kinoplasmic fibers present form a delicate weft about the nucleus. In Fig. 2 the weft is more pronounced and it is seen to retreat from the nucleus at two opposite points forming the cap-like spaces or courts described by Nemec. In Fig. 2 it is not assumed that the fibers

which converge toward the cell wall indicate the poles of the future spindle, but they lie in the equatorial region. It is clear that the spindle shown in Fig. 8 arose from such an anlage as Fig. 2. In these first two figures mentioned, the chromatin thread had not segmented into chromosomes, so that it may be asserted with all certainty that the anlage of the spindle may appear in *Allium* before the segmentation into chromosomes.

The fibers of this weft, as they assume more and more a longitudinal direction, form cone-shaped masses of spindle fibers on opposite side of the nucleus. These cone-shaped caps may at first enclose a space nearly free from kinoplasmic fibers; but later fibers penetrate the cone- or cylindrical-shaped spaces and become attached to the nucleus membrane.

Very frequently the fibers forming the periphery of the conical cap are arranged so closely together as to give in optical section, the appearance of a membrane defining a hyaline space on opposite sides of the nucleus, similar to that described by Nemec.

In some cases, however, it seems evident that the spindle anlage does not consist of two distinct halves, but certain fibers extend from one polar region to the other, a condition which must necessarily follow in case the fibers form a weft in the beginning (Figs. 2, 3 and 6).

It may be reasonably questioned whether such stages as represented in Figs. 3, 4 and 5 ever passed through that of Figs. 2 or 1. There was nothing in the appearance of the nucleus which could justify the unqualified assertion that Fig. 3 or Fig. 4 was a later stage than Fig. 2, yet much may depend upon whether the division follows a period of longer rest or whether it was one of a more rapid succession of divisions. We shall return to this phase of the subject later on.

It is evident from Figs. 3, 4 and 5 that we have to do with mono-axial spindle anlages which are not necessarily strictly bipolar, although this is sometimes true. Frequently fibers of the anlage may converge into one point at one end and into more than one at the other (Figs. 3 and 4), but the developing spindle is not so pronouncedly multipolar as in reproductive cells (Mottier, '97).

It is a matter of frequent observation that the fibers on one side of the nucleus are much longer than those at the other

(Fig. 4). Whether this fact has any special significance can not be stated at present.

During the stage just mentioned, the chromatin thread is in the form of the hollow spirem. The longitudinal splitting has taken place earlier as described by Mottier. In all the stages following those represented in Fig. 1 until the separation of the chromosomes at the equatorial plate this longitudinal splitting exists, but it is not shown in all the figures, for the process of staining necessary to bring out the spindle fibers clearly, leaves the chromosomes too densely stained to enable one to distinguish the daughter segments.

The next important step in the process is the gradual disappearance of the nuclear membrane. This appears first on the sides next to the poles (Fig. 6). The kinoplasmic fibers enter the nuclear cavity. Many attach themselves to the chromosomes while others are seen to extend from pole to pole (Figs. 7, 8). In Figs. 6, 7, 8, the poles of the spindle are broadly truncate, although generally at this stage they are sharp pointed. The chromosomes are somewhat crowded in the equatorial region but they have not as yet become oriented into the equatorial plate of the mature spindle. This behavior of the chromosomes during the disappearance of the nuclear membrane and the penetration of the spindle fibers into the nuclear cavity, is similar to that which has been observed in pollen-mother cells (Mottier, '97).

Fig. 11 is instructive in that several distinct poles are still present in each polar region. The arrangement of the chromosomes in this figure shows clearly that it is of the same stage in development as Figs. 7 and 8. In the mature spindle here as in reproductive cells, three sets of spindle fibers may be distinguished, namely: those which extend from the poles to the chromosomes to which they are fastened, those running from pole to pole, and the so-called mantle fibers which diverge from the poles toward the periphery of the cell in the equatorial region (Figs. 8 and 11).

In the mature spindle the chromosomes are often quite regularly arranged in the equatorial plate forming the well-known monaster (Fig. 12). Frequently they do not appear to be oriented with such regularity. At this stage the spindle is as a rule strictly bipolar, but sometimes (Fig. 12) two or more poles still persist.

Another interesting phenomenon is presented in Figs. 5, 9, and 10. Here the chromatin spirem remains unsegmented at a much later period. In Fig. 5 the spindle anlage is a monoaxial bipolar structure, while the chromatin thread remains in the form of a continuous spirem. The same seems to be true also in Fig. 10, but here the nuclear membrane has disappeared and the spindle has reached a later stage in development. (The free ends shown in the drawing represents part of the spirem cut by the knife in sectioning.) The nucleolus is still present. In Fig. 9 the spirem is partly segmented. The chromosomes when in the equatorial plate are either straight rods or bent somewhat **u** or **j**-shaped. They are attached to the spindle fibers either at the ends or at the point of bending. Their evolution during metakinesis and the anaphase are so well known that a repetition here would be without value.

Although the spindle fibers may not in some cases be united into a common point or pole when the spindle is mature (Fig. 12), yet the several points or poles into which portions of the spindle fibers converge almost invariably unite into a single pole sometime during the anaphase.

Fig. 13 is a typical karyokinetic figure during the anaphase. The three sets of spindle fibers mentioned above are seen with great clearness. When the spindle fibers are relatively abundant it is readily seen that their arrangement is the same as in reproductive cells.

A marked contrast between the karyokinetic spindle in vegetative and reproductive cells in the higher plants and especially in the Liliaceae is the small quantity of spindle fibers in the former. This is one of the principal reasons why the process here is more difficult to follow. The spindle fibers are often comparatively few and difficult to stain sufficiently to enable the observer to trace them in detail, and at the same time to prevent over straining of the remaining cytoplasm which would invariably conceal the delicate fibers.

Fig. 14 shows the origin of the cell plate which is laid down here as in pollen-mother cells. The daughter chromosomes which are very regular in this particular case seem to be forming at once a daughter spirem by the union of their free ends.

From the foregoing it will be seen that the early development of the spindle does not quite agree with the observations of Hof ('98) on *Ephedra* in which it is claimed that no trace of the spindle appears until after the segmentation of the chromosomes. The segmentation of the chromatin spirem into the individual chromosomes represents a definite phase in the development of the karyokinetic process, yet the time when it occurs as measured by a certain stage in the formation of the spindle may not seem to be of much importance since it has been shown that the time of segmentation varies much under different conditions in embryo-sac and in pollen-mother-cells and we find this to be true also in vegetative cells.

In the first nuclear division in embryo-sac and pollen-mother-cells (Mottier, '97), the chromatin thread is segmented sometime before the nuclear membrane disappears and before a definite spindle is present; but in the two succeeding divisions in the embryo-sac and the second one in the pollen-mother-cell, which take place in a rather rapid succession, the nuclear membrane disappears and a definite spindle may be developed before the segmentation into chromosomes.

The first nuclear division in the pollen- and embryo-sac-mother-cells is preceded by a long period of growth in which the nucleus is in a resting stage characterized by the fine nuclear reticulum, whereas the second and succeeding divisions in the embryo-sac of *Lilium* follow a much shorter period of rest. In the pollen-mother-cell, as is well known, the nucleus does not enter the complete state of rest at all before the second division.

Hof has observed that in vegetative cells one nuclear division may follow another in rapid succession without the intervention of the period of complete rest, and we are convinced that the same often happens in *Allium*. In the light of this fact, therefore, it is possible that such conditions as revealed in Figs. 5, 9 and 10 represent nuclei which are dividing without having passed through the stage of complete rest. Here as in the embryo-sac the spindle has probably advanced farther before the segmentation of chromosomes. The possibility is also not excluded that in Fig. 14 we have the chromosomes uniting to form a hollow spirem to be a corresponding stage in a rapidly succeeding division.

In regard to the presence of centrosomes or centrospheres as claimed by Guignard and Schaffner ('98), I must assert with all emphasis that no such organs exist in the root-tip of *Allium*. In view of the development of the spindle through a multipolar structure as discovered by Belajeff ('94) and confirmed by other observers, and in the presence of well-fixed and well-stained preparations which show every step in the process it seems well-nigh incredible that any one should be able at the present day to read centrosomes or centrospheres into the process.

In view of the foregoing observations it is quite clear that the process of spindle formation in vegetative cells of the higher plants is not essentially different from that observed in reproductive cells of those plants. In both cases the spindle fibers, or at least the vast majority of them, are of cytoplasmic origin. They may either appear at first in the form of a weft about the nucleus or radiate from it. It matters little or nothing whether they radiate uniformly from the entire surface of the nucleus or are confined to two opposite sides. In the vegetative cells in question the spindle anlage may be monoaxial and strictly bipolar from the first, but it is often multipolar.

Whether the anlage be multipolar and polyaxial or multipolar and monoaxial seems to be of little importance. The spindle in all phases of its development is a product of the kinoplasmic fibers without the intervention or instrumentality of individualized kinetic centers such as centrospheres or centrosomes.

This work was carried out in the botanical laboratories of Indiana University under the direction of Prof. D. M. Mottier who so kindly gave me the benefit of his larger experience in similar investigations both in the making of preparations and in the interpretation of results.

Explanation of Figures 24 and 25

All figures drawn from microtome sections by the aid of a camera lucida and Bausch and Lomb $\frac{1}{12}$ oil immersion and oculars one inch and two inch.

All figures refer to *Allium cepa*.

Fig. 1. A cell in which a very delicate weft of kinoplasmic fibers appear about the nucleus. Chromatin thread is not segmented into chromosomes; the free ends indicate where the spirem was cut by the knife.

Fig. 2. The weft of kinoplasmic fibers is removed some distance from the nuclear membrane on two opposite sides, thus forming a colorless space between it and the nucleus. The fibers of the weft diverge on the right and left toward the cell wall.

FIG. 3. The spindle anlage consists of two cone-shaped caps on opposite sides of the nucleus. The fibers converge into one pole at the lower end, but form two or more at the upper end.

FIG. 4. Similar spindle anlage, but both poles broadly truncate.

FIG. 5. Spindle anlage similar to Fig. 4. The chromatin spirem which winds regularly in the nucleus is drawn as seen from the surface.

FIG. 6. The spindle anlage consists of a cylindrical complex of fibers in which the nucleus lies. The nuclear membrane has begun to disappear.

FIG. 7. The nuclear membrane has disappeared. The chromosomes are being oriented in the nuclear plate; the spindle poles are very truncate.

FIG. 8. Similar to Fig. 7. The mantle fibers are more pronounced.

FIG. 9. Chromatin more crowded in the center of the spindle-fiber complex. Segmentation of spirem has probably taken place.

FIG. 10. Chromatin spirem in all probability unsegmented; it is much contracted; a large nucleolus is still present. The chromatin in Figs. 9 and 10 seem to indicate that these divisions were not preceded by a period of complete rest.

FIG. 11. Spindle monoaxial but multipolar; chromosomes not quite arranged in the equatorial plate.

FIG. 12. Chromosomes arranged in the nuclear plate; the spindle is still multipolar in this case, but in this stage it is usually strictly bipolar. This is a mature spindle.

FIG. 13. Karyokinetic figure in an aphase.

FIG. 14. Chromosomes have arrived at the poles; the cell plate is being laid down in the connecting fibers.

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Botanical Club of the A. A. A. S.

PROGRAM OF THE NEW YORK MEETING OF 1900

The meetings were under the chairmanship of Prof. F. S. Earle, of Auburn, Ala.

The following papers were presented:

F. C. Stewart, "Notes on some Fruit Diseases."

L. C. Corbett, "Transpiration Apparatus."

O. F. Cook (presented by C. L. Pollard), "The Method of Types in Botanical Nomenclature."

C. O. Townsend, "The Effect of Hydrocyanic Gas upon Fungi and Fungus Spores."

W. A. Kellerman, "A Foliicolous Form of *Ustilago Reiliana*."

F. E. Lloyd, "Notes on Nectaries in Ferns."

C. L. Pollard, "The Washington Biologists' Field Club."

S. M. Tracy, "Notes on the Florida Flora."

The officers for the ensuing year were elected as follows:

President, Professor L. H. Pammell, Ames, Ia.

Secretary, Roscoe Pound, Lincoln, Nebraska.

FRANCIS LLOYD,
Secretary.

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